

Claims

1 Sub B' 1. A method for encoding a sequence of video
2 frames comprising for each frame of the sequence of
3 video frames:

4 (a) encoding said frame employing at least
5 one controllable parameter; and

6 (b) adapting said encoding (a) of said
7 frame when said frame is a still frame, said
8 adapting including adjusting said at least one
9 controllable parameter employed in encoding said
10 still frame to minimize pulsation artifacts
11 between still frames of a sequence of still
12 frames within said sequence of video frames,
13 wherein said still frame comprises one still
14 frame of said sequence of still frames.

1 2. The method of claim 1, further comprising
2 determining whether said frame comprises said still
3 frame.

1 3. The method of claim 2, wherein each frame
2 of the sequence of video frames comprises a plurality
3 of pixels, and wherein each pixel of each frame
4 comprises a multi-bit value and said determining
5 comprises:

6 determining for a current frame (k+1) of
7 the sequence of frames a summation statistic
8 (PIX-SUM_{k+1}) derived from said multi-bit values
9 of the plurality of pixels of the current frame;

10 determining a summation statistic (PIX-
11 SUM_k) derived from the multi-bit values of the
12 plurality of pixels of a prior frame (k)
13 preceding the current frame (k+1) in the
14 sequence of video frames; and

15 determining whether:

16 $| \text{PIX-SUM}_k - \text{PIX-SUM}_{k+1} | < X$

17 where X is a predefined value representative of
18 a still frame.

1 4. The method of claim 3, wherein said
2 determining further comprises:

3 determining an accumulated absolute
4 difference derived from adjacent pixels of said
5 plurality of pixels of the current frame (PIX-
6 DIFF_{k+1});

7 determining an accumulated absolute
8 difference derived from adjacent pixels of said
9 prior frame (PIX-DIFF_k); and

10 determining whether:

11 $|PIX-DIFF_k - PIX-DIFF_{k+1}| < Y$

12 wherein Y is a predefined value, and
13 wherein said current frame is determined to
14 comprise said still frame if both $|PIX-SUM_k -$
15 $PIX-SUM_{k+1}| < X$ and $|PIX-DIFF_k - PIX-DIFF_{k+1}| < Y$
16 are true.

1 5. The method of claim 4, wherein said
2 determining further comprises dividing the current
3 frame and the prior frame into z corresponding
4 regions, and wherein said determining comprises
5 determining whether for each of said z corresponding
6 regions:

7 $|PIX-SUM_{kz} - PIX-SUM_{(k+1)z}| < X.$

1 6. The method of claim 5, wherein $X=256$,
2 $Y=256$, and $z \geq 4$, and wherein said four corresponding
3 regions of said current frame and said prior frame
4 comprise four horizontal bands.

1 7. The method of claim 2, further comprising
2 determining whether said frame comprises a reference
3 (I) still frame for said sequence of still frames and
4 if so increasing a target bitrate to be used by said
5 encoding (a) to encode said reference still frame.

1 8. The method of claim 7, wherein said
2 increasing of the target bitrate for said reference
3 still frame comprises detecting a subsequent B or P
4 still frame in said sequence of still frames and
5 moving target bits from said subsequent B or P still
6 frame to said reference still frame.

1 9. The method of claim 8, wherein said moving
2 of target bits comprises moving fifty percent of
3 target bits for encoding said subsequent B or P still
4 frame to encoding of said reference still frame.

1 10. The method of claim 2, wherein each frame
2 comprises a plurality of macroblocks, and said method
3 further comprises setting a zero motion vector mode
4 ON upon determining that said frame comprises a still
5 frame, and determining a predictive error for each
6 macroblock of said still frame, and when said
7 predictive error is less than a predetermined value,
8 setting said predictive error to zero making said
9 macroblock a skip macroblock.

1 11. The method of claim 10, further comprising
2 calculating a quantization level (QL) for said skip
3 macroblock for use in encoding said macroblock, and
4 comparing the calculated quantization level (QL) to
5 an average quantization level of a reference still
6 frame ($Av\ QL_{ref}$) of said sequence of still frames and
7 replacing said calculated quantization level with
8 said average quantization level of said reference
9 still frame when said calculated quantization level
10 is less than said average quantization level of said
11 reference still frame.

1 12. The method of claim 1, wherein when said
2 frame comprises a still frame, said adapting (b)
3 comprises defining a plurality of macroblocks in said
4 still frame as skip macroblocks, and maintaining a
5 minimum quantization level for encoding (a) of each
6 skip macroblock of said still frame.

1 13. The method of claim 12, wherein said
2 adapting (b) comprises maintaining said minimum
3 quantization level for each skip macroblock of said
4 still frame to be an average quantization level of a
5 reference still frame ($Av\ QL_{ref}$) for said sequence of
6 still frames.

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14. The method of claim 2, wherein said frame comprises a plurality of macroblocks, and wherein said determining comprises determining whether said frame comprises a motion frame, and when so, said method further comprises for each of at least some macroblocks of said motion frame:

(i) determining whether said macroblock comprises a still macroblock;

(ii) encoding said macroblock employing at least one controllable parameter; and

(iii) adapting said encoding of said macroblock when said determining (i) determines said macroblock to be said still macroblock, said adapting including adjusting said at least one controllable parameter employed in encoding said still macroblock to minimize pulsation artifacts between corresponding still macroblocks of adjacent frames in said sequence of video frames.

1 15. The method of claim 14, wherein said
2 adapting of said encoding comprises confirming that
3 said still macroblock is other than an edge
4 macroblock and is a non-intra macroblock, and that
5 said frame comprises a P frame, and when confirmed,
6 said method further comprises: determining that a
7 motion vector for said still macroblock is zero and a
8 macroblock difference (MBD) value is less than a
9 predefined value, and when true, encoding said still
10 macroblock as a skip macroblock and assigning a
11 minimum quantization level to said skip macroblock.

1 16. The method of claim 15, wherein said
2 assigning of the minimum quantization level comprises
3 assigning an average quantization level for a
4 reference frame for said P frame as quantization
5 level for said skip macroblock.

1 17. The method of claim 14, wherein said
2 adapting of said encoding comprising confirming that
3 said still macroblock is other than an edge
4 macroblock and is a non-intra macroblock, and that
5 said frame comprises a B frame, and when confirmed,
6 said method further comprises: determining that a
7 motion vector for said still macroblock is equal to a
8 motion vector of a previous macroblock in the B frame
9 and that a macroblock difference (MBD) value is less
10 than a predefined value, and if so, then encoding
11 said still macroblock as a skip macroblock and
12 assigning a minimum quantization level to said skip
13 macroblock.

1 18. The method of claim 17, wherein said
2 assigning of the minimum quantization level comprises
3 assigning an average quantization level for a
4 reference frame for said B frame as quantization
5 level for said skip macroblock.

19. A method for encoding a frame of a sequence
of video frames, said frame having a plurality of
macroblocks, said method comprising for each of at
least some macroblocks of said plurality of
macroblocks:

(a) encoding said macroblock employing at
least one controllable parameter; and

(b) adapting said encoding of said
macroblock when said macroblock is a still
macroblock, said adapting including adjusting
said at least one controllable parameter
employed in encoding said still macroblock to
minimize pulsation artifacts between
corresponding still macroblocks of adjacent
frames in said sequence of video frames.

20. The method of claim 19, further comprising
determining whether said macroblock comprises said
still macroblock.

21. The method of claim 19, wherein said
adapting of said encoding comprises encoding said
still macroblock as a skip macroblock and assigning a
minimum quantization level to said skip macroblock.

22. The method of claim 20, wherein said
assigning of the minimum quantization level comprises
assigning an average quantization level of a
reference frame to said frame as said minimum
quantization level for said still macroblock.

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23. A system for encoding a sequence of video frames comprising:

a pre-encode processing unit, said pre-encode processing unit comprising:

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a statistics measurement unit for use in determining whether a current frame of the sequence of frames comprises a still frame;

a control unit for modifying at least one controllable parameter employed in encoding said still frame to minimize pulsation artifacts between still frames of a sequence of still frames when said statistics measurement unit determines said current frame to comprise said still frame; and

an encoding engine for encoding said current frame of the sequence of video frames using the at least one controllable encode parameter set by said pre-encode processing unit.

24. The system of claim 23, wherein said statistics measurement unit comprises means for determining whether said current frame comprises a reference still frame, and if so, said control unit comprises means for increasing a target bitrate used by the encoding engine to encode said reference still frame.

1 25. The system of claim 24, wherein said means
2 for increasing said target bitrate comprises means
3 for transferring target bits from a subsequent still
4 frame in a sequence of still frames to said reference
5 still frame, said reference still frame also being in
6 said sequence of still frames.

1 26. The system of claim 23, wherein each frame
2 of said sequence of video frames comprises a
3 plurality of macroblocks, and wherein said control
4 unit of said pre-encode processing unit further
5 comprises means for setting zero motion vector mode
6 ON upon determining that said frame comprises a still
7 frame, and means for determining a predictive error
8 for each macroblock of said still frame, and for each
9 macroblock of said still frame for setting its
10 predictive error to zero making said macroblock a
11 skip macroblock when its determined predictive error
12 is less than a predetermined value representative of
13 a still macroblock.

1 27. The system of claim 26, wherein said
2 control unit further comprises means for maintaining
3 a minimum quantization level for encoding each skip
4 macroblock of said still frame.

1 28. The system of claim 27, wherein said means
2 for maintaining comprises means for maintaining said
3 minimum quantization level for each skip macroblock
4 of said still frame at an average quantization level
5 of a reference still frame ($Av\ QL_{ref}$) for said
6 sequence of still frames.

1 29. The system of claim 23, wherein each frame
2 of the sequence of video frames comprises a plurality
3 of pixels, and wherein each pixel of each frame
4 comprises a multi-bit value, and said statistics
5 measurement unit comprises means for:

6 determining for a current frame (k+1) of
7 the sequence of frames a summation statistic
8 (PIX-SUM_{k+1}) derived from said multi-bit values
9 of the plurality of pixels of the current frame;

10 determining a summation statistic (PIX-
11 SUM_k) derived from the multi-bit values of the
12 plurality of pixels of a prior frame (k)
13 preceding the current frame (k+1) in the
14 sequence of video frames; and

15 determining whether:

16
$$|\text{PIX-SUM}_k - \text{PIX-SUM}_{k+1}| < X$$

17 where X is a predefined value representative of
18 a still frame.

1 32. The system of claim 31, wherein said means
2 for adapting comprises means for confirming that said
3 still macroblock is other than an edge macroblock and
4 is a non-intra macroblock, and that said frame
5 comprises a P frame, and wherein said control unit
6 further includes means for determining that a motion
7 vector for said still macroblock is zero and a
8 macroblock difference (MBD) value is less than a
9 predefined value, and when true, said encoding engine
10 further comprises means for encoding said still
11 macroblock as a skip macroblock having a minimum
12 quantization level defined by a quantization level of
13 a reference frame for said P frame.

1 33. The system of claim 31, wherein said means
2 for adapting comprises means for confirming that said
3 still macroblock is other than an edge macroblock and
4 is a non-intra macroblock, and that said frame
5 comprises a B frame, and wherein said control unit
6 further comprises means for determining that a motion
7 vector for said still macroblock is equal to a motion
8 vector of a previous macroblock in the B frame and
9 that a macroblock difference (MBD) value is less than
10 a predefined value, and when true, said encoding
11 engine further comprises means for encoding said
12 still macroblock as a skip macroblock having a
13 minimum quantization level to said skip macroblock,
14 defined by a quantization level of a reference frame
15 for said B frame.

1 *Sub B⁶* 34. A system for encoding a macroblock of a
2 plurality of macroblocks of a frame in a sequence of
3 video frames, said system comprising:

4 an encoding engine for encoding said
5 macroblock of said frame using at least one
6 controllable encode parameter; and

7 *CH* means for adapting said encoding of said
8 macroblock when said macroblock is a still
9 macroblock, said adapting including means for
10 adjusting said at least one controllable
11 parameter employed in encoding said still
12 macroblock to minimize pulsation artifacts
13 between corresponding still macroblocks of
14 adjacent frames in said sequence of video
15 frames.

1 35. The system of claim 34, further comprising
2 means for determining whether said macroblock
3 comprises said still macroblock.

1 36. The system of claim 35, wherein said means
2 for adapting of said encoding comprises means for
3 adjusting encoding of said still macroblock to encode
4 said still macroblock as a skip macroblock and to
5 encode said skip macroblock with a minimum
6 quantization level defined by a quantization level of
7 a reference frame to said frame having said still
8 macroblock.

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37. A computer program product comprising a computer usable medium having computer readable program code means therein for use in encoding a sequence of video frames, said computer readable program code means in said computer program product comprising for each frame of the sequence of video frames:

8 computer readable program code means for
9 causing a computer to affect determining whether
10 said frame comprises a still frame;

11 computer readable program code means for
12 causing a computer to affect encoding said frame
13 employing at least one controllable encode
14 parameter; and

computer readable program code means for causing a computer to affect adapting said encoding of said frame when said determining determines said frame to be said still frame, said adapting including adjusting said at least one controllable parameter employed in encoding said still frame to minimize pulsation artifacts between still frames of a sequence of still frames within said sequence of video frames, wherein said still frame comprises one still frame of said sequence of still frames.

1 38. The computer readable program code means of
2 claim 37, wherein said computer readable program code
3 means for causing a computer to affect determining
4 comprises computer readable program code means for
5 causing a computer to affect determining whether said
6 frame comprises a reference (I) still frame for said
7 sequence of still frames, and when so, said computer
8 readable program code means for causing a computer to
9 affect adapting comprises computer readable program
10 code means for causing a computer to affect
11 increasing a target bitrate to be used by said
12 encoding to encode said reference still frame by
13 moving target bits from at least one subsequent still
14 frame of said sequence of still frames to said
15 reference still frame.

1 39. The computer readable program code means of
2 claim 38, wherein each frame of said sequence of
3 video frames comprises a plurality of macroblocks,
4 and wherein said computer readable program code means
5 for causing a computer to affect adapting comprises
6 computer readable program code means for causing a
7 computer to affect setting a zero motion vector mode
8 ON upon determining that said frame comprises said
9 still frame, and for determining a predictive error
10 for each macroblock of said still frame, and when
11 said predictive error is less than a predetermined
12 value, for setting said predictive error to zero
13 making said macroblock a skip macroblock.

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2 41. The computer readable program code means of
3 claim 37, wherein said frame comprises a plurality of
4 macroblocks, and wherein said computer readable
5 program code means for causing a computer to affect
6 determining comprises computer readable program code
7 means for causing a computer to affect determining
8 whether said frame comprises a motion frame, and when
9 so, said computer readable program code means further
10 comprises for each of at least some macroblocks of
said motion frame:

11 computer readable program code means for
12 causing a computer to affect determining whether
13 said macroblock comprises a still macroblock;

14 computer readable program code means for
15 causing a computer to affect encoding said
16 macroblock employing at least one controllable
17 parameter; and

18 computer readable program code means for
19 causing a computer to affect adapting said
20 encoding of said macroblock when said macroblock
21 comprises said still macroblock, said adapting
22 including adjusting said at least one
23 controllable parameter employed in encoding
24 said still macroblock to minimize pulsation
25 artifacts between corresponding still
26 macroblocks of adjacent frames in said sequence
27 of video frames.

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